

WHAT IS CLAIMED IS:

1 1. A method for interactive volume rendering of substantial amounts of
2 volume data in form of a stack of original 2-dimensional slices into displayable images on a
3 display of a personal computer, said personal computer having at least one graphics
4 processing unit, comprising:
5 reconstructing a 3-dimensional texture map of said volume data from
6 processed 2-dimensional slices taken from said original 2-dimensional slices;
7 segmenting said 3-dimensional texture map into three stacks of 3-dimensional-
8 textured slices;
9 rescaling said 3-dimensional-textured slices so that each slice edge dimension
10 is of an integer power of two to yield rescaled 2-dimensional slices;
11 subdividing each said rescaled 2-dimensional slice into grids of blocks with
12 corresponding depth and texture coordinate information;
13 in response to input designating view and size of image display of said volume
14 data, carrying out selected transformations, including at least translation, rotation, scaling and
15 plane-clipping, on said grids of blocks;
16 performing a two-pass rendering process on said grids of blocks comprising a
17 virtual rendering pass in order to compute information of view-dependent unused blocks, and
18 a main rendering pass in order to obtain processed blocks for further filtration; and
19 applying block-based fragment filtration to the processed blocks to obtain
20 image elements suited for display and to render a final image.

1 2. The method according to claim 1 wherein said 3-dimensional-textured
2 slices are axis-aligned.

1 3. The method according to claim 1 wherein the slice subdividing step
2 comprises:
3 dividing each said rescaled 2-dimensional slice into a grid of regular square
4 blocks of smaller texture, the edge dimension of each said block being of an integer power of
5 two., while associating an index with each said block.

1 4. The method according to claim 3 further including the step of storing
2 vertex coordinates and corresponding texture coordinates of said blocks.

1 5. The method according to claim 1 wherein
2 said virtual rendering pass includes rendering said volume data to compute
3 view dependent visibility information, and storing said visibility information in system
4 memory; and wherein
5 said main rendering pass includes static block filtration and dynamic block
6 filtration while rendering said final image;
7 storing current rendering status, including at least current translation status,
8 current rotation status, current scaling status and current plane-clipping status in the system
9 memory; and
10 sharing said current rendering status between said main rendering pass and
11 said virtual rendering pass.

1 6. The method according to claim 5 wherein
2 a main rendering thread is allocated to a single main graphics slot, and at least
3 one virtual rendering thread is allocated to side graphics slots.

1 7. The method according to claim 6 wherein said main rendering thread
2 and at least one said virtual rendering thread are distributed among a plurality of graphics
3 processing units.

1 8. The method according to claim 5 wherein said virtual volume
2 rendering step includes:
3 selecting a corresponding stack out of three said axis-aligned grids of blocks
4 according to current translational status and current rotational status of said volume data;
5 retrieving vertex information of every said block;
6 storing identity of every block within said corresponding stack as color
7 texture;
8 applying any clipping planes onto the rendering procedure;
9 combining color texture, alpha texture and vertex buffer to yield combined
10 texture; and
11 rendering said combined texture to a virtual rendered item buffer, in order to
12 compute information of any non-viewable blocks in preparation for transferring identity of
13 viewable blocks of the virtual screen buffer to the system memory.

1 9. The method according to claim 8 wherein the combined texture
2 rendering step is a multi-GPU process using a plurality of vertex shaders and fragment
3 shaders in said virtual rendering.

1 10. The method according to claim 9 wherein the multi-GPU process
2 includes:

3 dividing said grids of blocks into different sets according an available number
4 of side graphics slots;

5 rendering different sets of slices to the virtual screen individually;

6 merging all visibility information; and

7 copying the resultant merged visibility information to system memory.

1 11. The method according to claim 5 wherein said main rendering pass
2 comprises:

3 performing the static block filtration to filter out view-independent blocks
4 including merely non-contributing signals and to obtain statically filtrated blocks; and

5 performing the dynamic block filtration to filter out view dependent blocks
6 due to occlusion.

1 12. The method according to claim 11 wherein, during the static block
2 filtration, each block in three said axis-aligned grids of blocks is processed to reduce unused
3 data, including:

4 providing the non-contributing signals as a set of specific color entries as a
5 filter set;

6 performing the static block filtration on each block in said grid of blocks to
7 filter out the non-contributing signals from the rasterization process according to said filter
8 set;

9 identifying blocks as to-be-removed if and only if the whole block is filled
10 only with colors from said filter set; and

11 recording indices of statically filtrated blocks.

1 13. The method according to claim 11 wherein the dynamic block filtration
2 step includes:

3 selecting a corresponding stack out of the three said axis-aligned grids of
4 blocks according to current translational status and current rotational status of said volume
5 data;
6 retrieving vertex information of said statically filtrated blocks;
7 reading the visibility information and a current projection matrix from the
8 system memory;
9 determining filtrate-blocks using the visibility information;
10 directing a vertex buffer of said filtrate-blocks to the vertex processor for
11 rasterization and processed textures coordinates to the fragment processor; and
12 rendering the final image by said vertex buffer with said 3-dimensional texture
13 map.